

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BOARD OF PATENT APPEALS AND INTERFERENCES**

In Re Application of: Donald A. Pile et al.)	Confirmation No.: 8048
)	
Serial No.: 10/764,246)	Examiner: Felton, Aileen Baker
)	
Filed: January 23, 2004)	Group Art Unit: 1755
)	
For: PRIMING MIXTURES FOR SMALL ARMS)	Docket No.: R087 1273.1 (27584.0294.3)

SUPPLEMENTAL APPEAL BRIEF

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Dear Sir:

This Supplemental Appeal Brief is being submitted in response to the Notice of Non-Compliant Appeal Brief, mailed May 23, 2008, and pursuant to 37 C.F.R. § 41.37 in support of the Notice of Appeal filed in the above-referenced Application on March 19, 2008. The Commissioner is hereby authorized to charge any necessary fees that may be required to Deposit Account No. 09-0528.

In response to the Notice of Non-Complaint Appeal Brief mailed May 23, 2008, Applicant/Appellant submits this Supplemental Appeal Brief, including a recitation of the status of claims 2, 17, 23-31, 39 and 42-43, which have been canceled as discussed below.

1. REAL PARTY IN INTEREST.

The Real Party in Interest in the present Application is RA Brands, LLC, the owner of the present Application by assignment from the named inventors, recorded on March 8, 2004 at Reel/Frame Number: 015048/0017.

2. RELATED APPEALS AND INTERFERENCES.

There are no other appeals or interferences known to Appellant, or Appellant's legal representatives, that will directly affect, will be affected by, or which have a bearing on the Board's decision in the pending Appeal.

3. STATUS OF CLAIMS.

Claims 1, 3-16, 18-22, 32-38, 40, 41, 44 and 45 are pending in the present Application. Claims 2, 17, 23-31, 39, and 42-43 were previously canceled in the "Response Under 37 C.F.R. 1.114(c) Accompanying RCE Filing," filed January 17, 2007. Claims 1, 3-16, 18-22, 32-38, 40, 41, 44 and 45 have been rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over *John, Jr. et al.* (6,478,903) in view of *Boberg* (5,654,520) or *Calsson* (4,853,052). A copy of the claims that are the subject of the present appeal, i.e., Claims 1, 3-16, 18-22, 32-38, 40, 41, 44 and 45 is set forth in the attached Claims Appendix.

4. STATUS OF AMENDMENTS.

On October 2, 2007, Appellant filed an Amendment and Response to which the Final Office Action of December 27, 2007 that is the subject of the present Appeal, was issued. Appellant filed a Notice of Appeal responsive to the December 27, 2007 Final Office Action on

March 19, 2008. No other responses or amendments have been filed with respect to the Final Office Action of December 27, 2007 following the Notice of Appeal filed March 19, 2008.

5. **SUMMARY OF CLAIMED SUBJECT MATTER.**

In accordance with 37 C.F.R. § 14.37, a concise explanation of the subject matter defined in the independent claims (Claims 1, 11, 22 and 32) involved in the present Appeal is set forth below in a tabular format. References to pages and lines of the specification of the present Application are designated by: "Page:Lines," and references to the drawings are indicated by "Fig." and associated reference characters.

<p>1. A primer mixture for small arms ammunition comprising:</p>	<p>Briefly described, the present invention generally encompasses compositions and methods of preparing priming mixtures for small arms ammunition comprising oxidizer systems containing bismuth oxide, as well as small arms ammunition cartridges that incorporate such priming mixtures. (Page 3: Lines 7-10).</p> <p>The present invention generally is directed to priming mixtures containing bismuth oxide primarily for use in small arms ammunition. (Page 5: Lines 14-15).</p>
<p>a primary explosive selected from the group consisting of: trinitroresorcinol, mercury fulminate, lead azide, lead styphnate, silver azide, diazodinitrophenol, tetrazene, potassium dinitrobenzofuroxane, heavy metal salts of 5-nitrotetrazole and any combination thereof; and</p>	<p>In one embodiment, the priming mixtures of the present invention include a primary explosive and a non-hygroscopic, non-corrosive oxidizer system comprising bismuth oxides. The primary explosive may be selected from heavy metal salts of trinitroresorcinol, dinitrobenzofuroxane, diazodinitrophenol and combinations thereof. The primary explosive also may include a lead-based compound such as lead styphnate. (Page 3: Line 18-Page 4: Line 1).</p> <p>The term "primary explosive" generally refers to a sensitive explosive which nearly always detonates by simple ignition from an energy source of appropriate magnitude</p>

	<p>for a small arm, such as spark, flame, impact and other primary heat sources. The term "primary explosive" further generally includes, but is not limited to, mercury fulminate, lead azide, lead styphnate, silver azide, diazodinitrophenol (DDNP), tetrazene, potassium dinitrobenzofuroxane (KDNEF), heavy metal salts of 5-nitrotetrazole and other</p> <p>compounds that exhibit performance characteristics of handling, storage of detonation similar to these example compounds. (Page 6: Line 10-15).</p>
<p>a non-hygroscopic, non-corrosive oxidizer system comprising bismuth oxide, wherein the bismuth oxide comprises at least 15% by weight of the priming mixture.</p>	<p>The present invention generally is directed to priming mixtures comprising an oxidizer system containing bismuth oxide. (Page 7: Lines 6-7). In one embodiment, the priming mixtures of the present invention include a primary explosive and a non-hygroscopic, non-corrosive oxidizer system comprising bismuth oxide. (Page 3: Lines 18-19). In another embodiment, the present invention includes priming mixtures for small arms ammunition comprising approximately 20-70 % by weight of a primary explosive, such as a lead-free explosive or a lead-based compound such as lead styphnate, and approximately 10-70% by weight of an oxidizer system comprising bismuth oxide. (Page 4: Lines 9-12).</p> <p>In particular embodiments, the priming mixtures of the present invention can include from about 10% to about 70% by weight of an oxidizer system comprising bismuth oxide alone or in combination with one or more other oxidizers, although greater or lesser amounts of the oxidizer can be used. In certain embodiments, the priming mixtures can contain about 25% to about 55% by weight of an oxidizer including bismuth oxide. This bismuth</p>

	oxide can constitute anywhere from about 1% up to about 100% by weight of the oxidizer system, and particularly about 5% to about 100% by weight of the oxidizer system. (Page 8: Lines 7-13).
11. A priming mixture for small arms ammunition comprising:	<p>Briefly described, the present invention generally encompasses compositions and methods of preparing priming mixtures for small arms ammunition comprising oxidizer systems containing bismuth oxide, as well as small arms ammunition cartridges that incorporate such priming mixtures. (Page 3: Lines 7-10).</p> <p>The present invention generally is directed to priming mixtures containing bismuth oxide primarily for use in small arms ammunition. (Page 5: Lines 14-15).</p>
about 20% to about 70% by weight of a primary explosive selected from the group consisting of: trinitroresorcinol, mercury fulminate, lead azide, lead styphnate, silver azide, diazodinitrophenol, tetrazene, potassium dinitrobenzofuroxane, heavy metal salts of 5-nitrotetrazole and any combination thereof;	<p>The priming mixtures of the present invention typically will include one or more primary explosives in a range of about 20% to about 70% by weight of priming mixture, although it is also possible to utilize greater or lesser percentages by weight of the primary explosive in the primary mixture as well. (Page 9: Lines 6-9).</p> <p>The term "primary explosive" generally refers to a sensitive explosive which nearly always detonates by simple ignition from an energy source of appropriate magnitude for a small arm, such as spark, flame, impact and other primary heat sources. The term "primary explosive" further generally includes, but is not limited to, mercury fulminate, lead azide, lead styphnate, silver azide, diazodinitrophenol (DDNP), tetrazene, potassium dinitrobenzofuroxane (KDNBF), heavy metal salts of 5-nitrotetrazole and other compounds that exhibit performance characteristics of handling, storage of detonation similar to these example</p>

	<p>compounds. (Page 6: Lines 10-15.)</p> <p>In addition to a bismuth oxide oxidizer system, the priming mixtures of the present invention generally include one or more primary explosives, such as, for example, lead salts of trinitroresorcinol, diazodinitrophenol, or earth metal salts of dinitrobenzofuroxane. In one embodiment, the priming mixture includes DDNP as one of the primary explosive constituents. DDNP can be used only, or in combination with one or more primary explosives, such as KDNBF, and derivatives and mixtures thereof, in the priming mixture. Alternatively, KDNBF may constitute the only primary explosive of the priming mixtures or comprise one of a combination of primary explosive components, other than DDNP. While DDNP and KDNBF are substantially free of lead and non-toxic, they can be used individually or together in combination with one or more lead-based primary explosives, such as lead styphnate or the like the priming mixtures containing bismuth oxide. (Page 8: Line 14-Page 9: Line 3).</p>
<p>about 10% to about 70% by weight of an oxidizer system comprising bismuth oxide, wherein the bismuth oxide comprises at least 15% by weight of the priming mixture;</p>	<p>In another embodiment, the present invention includes priming mixtures for small arms ammunition, comprising approximately 20-70% by weight of a primary explosive, such as a lead-free explosive or a lead-based compound such as lead styphnate, and approximately 10-70% by weight of an oxidizer system comprising bismuth oxide. (Page 4: Lines 9-12).</p> <p>In particular embodiments, the priming mixtures of the present invention can include from about 10% to about 70% by weight of an oxidizer system comprising bismuth oxide alone or in combination with one or more other oxidizers, although greater or lesser amounts of the oxidizer</p>

	<p>can be used. In certain embodiments, the priming mixtures can contain about 25% to about 55% by weight of an oxidizer system including bismuth oxide. This bismuth oxide can constitute any where from about 1% up to about 100% by weight of the oxidizer system, and particularly about 5% to about 100% by weight of the oxidizer system. (Page 8: Lines 7-13).</p>
<p>about 0% to about 25% by weight of a gas producing agent;</p>	<p>These priming mixtures optionally may include approximately 0-25% by weight of a gas producing agent, approximately 0-20% by weight of a sensitizer, and approximately 0-20% by weight of a reducing agent. (Page 4: Lines 12-14).</p> <p>Gas producing agents also can be included in the priming mixtures of the present invention. Single or double based propellants, such as pentaerythritol tetranitrate or trinitrotoluene, can be included to provide sources of expanding gas when the priming mixture is activated. Generally, the priming mixtures can include about 0% to about 5% by weight of one or more gas producing agents. In one particular embodiment, the priming mixture comprises about 5% to about 25% by weight of a gas producing agent. (Page 10: Lines 10-15).</p>

<p>about 0% to about 20% by weight of a sensitizer; and,</p>	<p>These priming mixtures optionally may include approximately 0-25% by weight of a gas producing agent, approximately 0-20% by weight of a sensitizer, and approximately 0-20% by weight of a reducing agent. (Page 4: Lines 12-14).</p> <p>The priming mixtures also can include sensitizers, typically in an amount from about 0% to about 30% by weight of the priming mixture. ... in one embodiment, the priming mixture contains about 5% to about 20% by weight of such materials, and in one particular embodiment, tetrazene typically is added to the mix in an amount between about 4 to 11% by weight. (Page 10: Lines 3-4; 6-8).</p>
<p>about 0% to about 20% by weight of reducing agent.</p>	<p>These priming mixtures optionally may include approximately 0-25% by weight of a gas producing agent, approximately 0-20% by weight of a sensitizer, and approximately 0-20% by weight of a reducing agent. (Page 4: Lines 12-14).</p> <p>The priming mixtures further can include one or more fuels or reducing agents. The fuel can be either a metallic fuel or reducing agent, non-metallic fuel, or combinations thereof. The fuel can constitute from about 0% to about 20% by weight of the priming mixture. (Page 10: Lines 16-18).</p>
<p>22. A small arms ammunition round comprising:</p>	<p>Briefly described, the present invention generally encompasses compositions and methods of preparing priming mixtures for small arms ammunition comprising oxidizer systems containing bismuth oxide, as well as small arms ammunition cartridges that incorporate such priming mixtures. (Page 3: Lines 7-10). These priming mixtures can be incorporated into small arms ammunition primers or cartridges, which are also encompassed by the present invention. (Page 5: Lines 18-</p>

	20).
a priming mixture as disclosed in Claim 11;	See Claim 11 above. The present invention generally is directed to priming mixtures containing bismuth oxide primarily for use in small arms ammunition. The primary mixtures generally include a primary explosive and an oxidizer system containing bismuth oxide by itself or in combination with one or more oxidizers. Other priming components, such as gas producing agents, sensitizers and reducing agents or fuels also may be included in the priming mixtures of the present invention. (Page 5: Lines 14-20).
a propellant adapted to be initiated by the priming mixture; and	<p>The term "priming mixture," as used herein, first to a combination of explosive and/or pyrotechnic type ingredients, which, when pressed into case-less ammunition or a primer cup were spun into the rim cavity of a rimfire shell, will explode or deflagrate upon impact by a firing-pin with a round of ammunition to ignite the propellant of the round and fire the bullet or slug of the round. (Page 6: Lines 4-8).</p> <p>The present invention also encompasses small arms ammunition cartridges that incorporate the priming mixtures described herein. The cartridges typically will include a case in which the priming mixture is disposed, although the priming mixture also could be used for case-less ammunition as well. ... the cartridge also can be a centerfire cartridge for rifles, pistols and revolvers in which the primer is essentially aligned within the head of the cartridge or a rimfire cartridge having a flanged head with the priming mixture disposed in the rim cavity. (Page 12: Lines 15-21).</p>

<p>a projectile.</p>	<p>The present invention also encompasses small arms ammunition cartridges that incorporate the priming mixtures described herein. The cartridges typically will include a case in which the priming mixture is disposed, although the priming mixture also could be used for case-less ammunition as well. The cartridge may include projectiles, such as shot or bullets. (Page 12: Lines 15-18).</p> <p>The term “priming mixture,” as used herein, first to a combination of explosive and/or pyrotechnic type ingredients, which, when pressed into case-less ammunition or a primer cup were spun into the rim cavity of a rim shell, will explode or deflagrate upon impact by a firing-pin with a round of ammunition to ignite the propellant of the round and fire the bullet or slug of the round. (Page 6: Lines 4-8).</p>
<p>32. A priming mixture for small arms ammunition comprising:</p>	<p>Briefly described, the present invention generally encompasses compositions and methods of preparing priming mixtures for small arms ammunition comprising oxidizer systems containing bismuth oxide, as well as small arms ammunition cartridges that incorporate such priming mixtures. (Page 3: Lines 7-10).</p>
<p>about 25% to about 50% by weight of a primary explosive selected from the group consisting of: trinitroresorcinol, mercury fulminate, lead azide, lead styphnate, silver azide, diazodinitrophenol, tetrazene, potassium dinitrobenzofuroxane, heavy metal salts of 5-nitrotetrazole and any combination thereof;</p>	<p>The priming mixtures of the present invention typically will include one or more primary explosives in a range of about 20% to about 70% by weight of priming mixture, although it is also possible to utilize greater or lesser percentages by weight of the primary explosive in the primary mixture as well. (Page 9: Lines 6-9).</p> <p>The term “primary explosive” generally refers to a sensitive explosive which nearly always detonates by simple ignition from an energy source of appropriate magnitude for a small arm, such as spark, flame,</p>

	<p>impact and other primary heat sources. The term "primary explosive" further generally includes, but is not limited to, mercury fulminate, lead azide, lead styphnate, silver azide, diazodinitrophenol (DDNPP, tetrazene, potassium dinitroenzofuraxane (KDNBF), heavy metal salts of 5-nitrotetrazole and other compounds that exhibit performance characteristics of handling, storage of detonation similar to these example compounds. (Page 6: Lines 10-15).</p> <p>In addition to a bismuth oxide oxidizer system, the priming mixtures of the present invention generally include one or more primary explosives, such as, for example, lead salts of trinitroresorcinol, diazodinitrophenol, or earth metal salts of dinitrobenzofuroxane. In one embodiment, the priming mixture includes DDNP as one of the primary explosive constituents. DDNP can be used only, or in combination with one or more primary explosives, such as KDNBF, and derivatives and mixtures thereof, in the priming mixture. Alternatively, KDNBF may constitute the only primary explosive of the priming mixtures or comprise one of a combination of primary explosive components, other than DDNP. While DDNP and KDNBF are substantially free of lead and non-toxic, they can be used individually or together in combination with one or more lead-based primary explosives, such as lead styphnate or the like the priming mixtures containing bismuth oxide. (Page 8: Line 14-Page 9: Line 3).</p>
as about 25% to about 55% by weight of an oxidizer system comprising bismuth oxide, wherein the bismuth oxide comprises at least 15% by weight of the priming mixture.	<p>In another embodiment, the present invention includes priming mixtures for small arms ammunition, comprising approximately 20-70% by weight of a primary explosive, such as a lead-free explosive or a lead-based compound such as lead styphnate, and approximately 10-</p>

	<p>70% by weight of an oxidizer system comprising bismuth oxide. (Page 4: Lines 9-12).</p> <p>In particular embodiments, the priming mixtures of the present invention can include from about 10% to about 70% by weight of an oxidizer system comprising bismuth oxide alone or in combination with one or more other oxidizers, although greater or lesser amounts of the oxidizer can be used. In certain embodiments, the priming mixtures can contain about 25% to about 55% by weight of an oxidizer system including bismuth oxide. This bismuth oxide can constitute any where from about 1% up to about 100% by weight of the oxidizer system, and particularly about 5% to about 100% by weight of the oxidizer system. (Page 8: Lines 7-13).</p>
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6. GROUND OF REJECTION TO BE REVIEWED ON APPEAL.

Claims 1, 3-16, 18-22, 32-38, 40, 41, 44 and 45 are pending in the present application.

Claims 1, 3-16, 18-22, 32-38, 40, 41, 44 and 45 have been rejected under 35 U.S.C. § 103(a) as purportedly being unpatentable over *John, Jr. et al.* (6,478,903) in view of *Boberg* (5,654,520) or *Calsson* (4,853,052).

7. ARGUMENT.

A. Rejection of Claims 1, 3-16, 18-22, 32-38, 40, 41, 44 and 45 based upon the attempted combination of *John, Jr.* and either *Boberg* or *Calsson* should be overturned as such references, considered in their entirety, appear to teach away from a combination of their teachings, and there is no clear reasoning supporting the rejection.

Pending Claims 1, 3-16, 18-22, 32-38, 40, 41, 44 and 45 were rejected in the final Office Action mailed December 27, 2007, as purportedly being unpatentable under 35 U.S.C. § 103(a) over *John, Jr., et al.* (6,478,903) in view of *Boberg* (5,654,520) or *Calsson* (4,853,052). The rejection asserts that *John, Jr.* discloses the composition substantially as claimed including the

use of an oxidizer, 20-70%, secondary explosive, a sensitizer such as tetrazine from 4-11% and a metallic fuel 2-20%. The rejection also states that *John, Jr.* includes bismuth sulfide as the fuel or inflammable material in the primer mix, but does not mention the use of bismuth oxide. The rejection instead cites *Boberg* (examples) and *Calsson* (Col. 2 Table) as allegedly teaching that it is known to use bismuth trioxide in amounts greater than 15% in a primer composition. The rejection thus concludes that “[It] would have been obvious to one of skill in the art at the time the invention was made to use the bismuth trioxide as taught by *Boberg* or *Calsson* with the composition of *John, Jr. et al.* since *Boberg* or *Calsson* suggests that the bismuth trioxide catalyst has been found to be applicable to priming mixtures generally and since *John, Jr. et al.* suggests the use of a bismuth salt for use in priming compositions.” The rejection also asserts that it is *prima facie* obvious to combine two compositions taught for the same purpose “to yield a third composition for that very purpose.”

Additionally, in response to prior arguments, the rejection asserts that while Applicant/Appellant has argued that the prior art doesn’t have similar burn rates to that of the claimed invention, such burn rates are not claimed and additionally that “the burn rate would be “an inherent property of a composition as disclosed and taught.” Additionally, the rejection asserts that though Applicant/Appellant argues there is no reason to combine the references, this “is unpersuasive since all references relate to priming compositions and thus it would be obvious to use the teachings of *Boberg* and *Calsson* since they indicate that it is known to add a bismuth trioxide catalyst priming composition to priming compositions.”

Appellant has traversed this rejection and respectfully submits that it should be overturned. As an initial matter, it should be recognized that primer compositions for small arms are significantly different in use, effect and composition than pyrotechnic charges for blasting

applications, artillery and other, similar type applications, and thus there are significant differences in the compositions taught by each of the cited references that would, rather than point toward their combination, lead one of ordinary skill in the art away from their combination. Hereafter, reference further is made to the declaration under 37 CFR § 1.132 (the "Declaration") of Donald Pile, a named inventor of this application. This Declaration was submitted with the response filed October 2, 2007. In brief, this Declaration presents evidence as to the knowledge of persons skilled in the munitions art or field, and why one of ordinary skill in the art would not find it obvious to try to modify the non-toxic primer mix of *John, Jr.* (developed as a substitute for lead styphnate based small arms primers) with the pyrotechnic delay charge taught by *Boberg*, or alternatively with the pyrotechnic delay or ignition charge taught by *Calsson*.

As noted, *John, Jr.* discloses non-toxic primer mixes that appear to have been developed for use in small arms as a substitute for lead styphnate-based primers. (See Col. 1, Lines 54-63, and Paragraph 8 of the Declaration). In small arms primer mixes, as opposed ignition or delay charges for setting off larger explosions, it is critical that the small arms round fire as near to simultaneously as possible with the pulling of the trigger. (See Paragraph 9 of the Declaration). If near simultaneous firing does not occur, the firearm can be reoriented or shifted during the delay between the trigger pull and the firing and discharge of the firearm. Such reorientation or shifting of the firearm, even by the slightest amount, can not only cause the shooter to miss their intended target, but also can cause the round to be fired in an unintended direction or location. The time between the trigger pull and the firing of the round for small arms applications, generally known as "lock time," thus needs to be minimized as much as possible in order to ensure accuracy and consistency in the firing of the firearm, especially for police and/or military applications where an inaccurate shot can mean the difference between life and death. As a

result, small arms primer mixes, such as *John, Jr.* and the claimed invention, are expressly designed to “detonate” at high velocities, as opposed to burning or “deflagrating” explosives in which the initiation and actuation of the primary explosive material would occur at relatively low velocities that generally are not suitable for small arms primer applications. (See Paragraph 16 of the Declaration). Accordingly, typical detonation velocities for small arms primer mixes generally are in the range of at least 4,500 meters per second. (See Paragraph 9 of the Declaration).

In contrast to both *John, Jr.* and the claimed invention, the pyrotechnic charges disclosed in *Calsson* generally are not suitable for use in small arms primer compositions or applications because of the express teaching in *Calsson* of the use of its primer mixes for specifically creating a pyrotechnical delay. (See Col. 1, L. 6-14). In fact, *Calsson* specifically recites that “[W]ithin the percentage concentrations characteristic of the present invention, the pyrotechnical charge may be given an optimal rate of burning of between 3 and 150 millimeters per second.” (Col. 1, L. 17-20 (emphasis added)). Thus, *Calsson* specifically discloses burn rates much slower than are generally acceptable for small arms primers, such as the claimed invention, with the upper range value of 150 millimeters per second being on the order of several orders of magnitude too slow for use in a small arms primer mix such as is disclosed in *John, Jr.* or for use in the claimed invention. (See Paragraph 19 of the Declaration). Additionally, while *Calsson* differentiates between “ignition” and “delay” charges in the table shown in Col. 2, at lines 41-53 the burn rates obtained in both *Calsson*’s delay and ignition charges would provide an unacceptable “delay” for a small arms primer mix if combined with the non-toxic small arms primer mix of *John, Jr.* In this Table 2 of *Calsson*, the ignition charge containing 49% bismuth trioxide is still recited as having a burn rate of only 50 millimeters per second, which is much less than the typical

detonation velocities of small arms primer mixes in the range of at least 4,500 feet per second as noted in Paragraph 9 of the Declaration.

Because *Calsson*'s charges are specifically addressed to generating a pyrotechnical delay, one of ordinary skill in the art would not have found it obvious to modify the primer mixes in *John, Jr.* using the teachings of *Calsson*. To the contrary, the specific teachings of pyrotechnic delay in *Calsson* would have deterred one of ordinary skill from modifying *John, Jr.* because of the expectation that a similar delay would be induced in *John, Jr.*'s modified primer composition. Such delay would destroy *John, Jr.*'s operability as a small arms primer composition, making the combination improper. If when combined, references produce an inoperative device, the references teach away from such combination. See *Tec Air, Inc. v. Denso Mfg. Michigan Inc.*, 52 USPQ 2d 1294, 1298 (Fed. Cir. 1999) (*quoting In re Spinnoble*, 160 USPQ 237, 244 (C.C.P.A. 1969)).

Similarly, the proposed combination of *John, Jr.* and *Boberg* likewise would not be effective or warranted. As an initial matter, there appear to be typographical errors in Examples 2, 4 and 5 of *Boberg*. Examples 2, 4 and 5 list burn rates measured in meters per second. These Examples conflict with the EP publication No. 0 599 792 B1 of the original Swedish priority document for *Boberg* - SE 9203571. EP 0 599 792 B1 (a copy of which is included in the Evidence Appendix attached herewith) lists the burn rates in corresponding Examples 2, 4 and 5 in millimeters per second, not meters, per second. The use of meters per second in Examples 2, 4 and 5 of *Boberg* also conflicts with *Boberg*'s stated "suitable burn rate" range of "between 10 to 200 mm/s" (col. 2, lines 34-36). Upon reviewing the example compositions and in consideration of the discrepancies between EP 0 599 792 B1 and *Boberg*, Declarant Pile also was

of the opinion that the burn rates in Examples 2, 4 and 5 of *Boberg* should be measured in millimeters, not meters, per second (see paragraphs 13-15 of the Declaration).

Accordingly, as in the case of *Calsson*, *Boberg*'s burn rates are several orders of magnitude too slow for use in a small arms primer mix such as is disclosed in *John, Jr.* (see paragraph 17 of the Declaration). Assuming the burn rate in Example 2 is correctly measured in millimeters per second, the fastest example burn rate in *Boberg* is only 100 millimeters per second. Because *Boberg*'s charges create delays in firing, one of ordinary skill in the art would not have found it obvious to modify the primer mixes in *John, Jr.* using the teachings of *Boberg*. On the contrary, one of ordinary skill in the art instead would likely be deterred from attempting such a combination because of the expected detrimental decrease in *John, Jr.*'s detonation velocity such that the two references teach away from each other. See *Tec Air*, 2 USPQ 2d at 1298.

Still further, the final rejection fails to articulate any clear reasoning for combining the delay and/or ignition charges of either *Boberg* or *Calsson* with the small arms primer mix of *John, Jr.* Instead, the rejection just generally asserts that these references indicate that "it is known to add a bismuth trioxide catalyst priming composition," and therefore the conclusory statement is made that it would be obvious to include it in the primer composition as disclosed by *John, Jr.* As noted MPEP § 2142, however, "the key to supporting any rejection under 35 U.S.C. § 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious." The Supreme Court in *KSR International Co. v. Teleflex, Inc.*, 550 U.S. ____, 82 USPQ 2d 1385, 1396 (2007), further expressly stated that any analysis supporting a rejection under "35 U.S.C. § 103 should be made explicit." See MPEP §§ 2141, 2142; and see *K.S.R.*, 550 U.S. at ____, 82 USPQ 2d at 1398; quoting *In re Kahn*, 441 F.3d 977, 988, 78 USPQ 2d

1329, 1326 (Fed. Cir. 2006): “[R]ejections on obviousness cannot be sustained by merely conclusory statements; instead there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” The present rejection of the pending claims, however, lacks such a definitive statement or “clearly articulated reasons” or explanation as to why or how the teachings of the delay charges of *Boberg* or *Calsson* could or should be combined with the small arms primer mix of *John, Jr.* to try to form the claimed invention. Instead, the examiner has impermissibly tried to select one individual element, bismuth trioxide, from the compositions of *Boberg* and/or *Calsson*, in view of the Applicant’s teaching of primer mixes utilizing bismuth oxide, without any support or statement as to how to make such a combination other than apparently relying on hindsight teaching in view of Applicant’s claimed invention.

Accordingly, it is submitted that the final rejection of Claims 1, 3-16, 18-22, 32-38, 40, 41, 44 and 45 under 35 U.S.C. § 103(a) is improper and should be overturned.

8. **CLAIMS APPENDIX.**

The claims appendix detailing the claims involved in the present appeal is attached hereto beginning on page 20.

9. **EVIDENCE APPENDIX.**

An evidence appendix is attached hereto beginning at page 24, and contains the Declaration of Donald Alan Pile submitted under 37 CFR § 1.132, and a copy of EP 0 599 792 B1. The Declaration and a copy of EP 0 599 792 B1 were previously filed in the present application with the response of October 2, 2007, and are being relied upon to support the present appeal.

10. **RELATED PROCEEDINGS APPENDIX.**

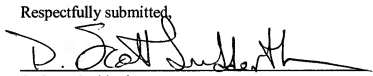
Since there are no related appeals and interferences, no decisions have been rendered or attached hereto. Further, since a court nor the Board in any proceeding is identified in the related appeals and interferences section, no decisions have been rendered or attached hereto.

11. **CONCLUSION.**

Claims 1, 3-16, 18-22, 32-38, 40, 41, 44 and 45 are not rendered obvious by and thus are patentable under 35 U.S.C. § 103(a) over the cited combination of *John, Jr.* in view of *Boberg* or *Calsson*. Accordingly, the rejections applied to Claims 1, 3-16, 18-22, 32-38, 40, 41, 44 and 45 should be overturned and these claims allowed.

Respectfully submitted,

Date: 5-29-08


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CLAIMS APPENDIX

Listing of Claims:

1. A priming mixture for small arms ammunition comprising:
 - a primary explosive selected from the group consisting of: trinitroresorcinol, mercury fulminate, lead azide, lead styphnate, silver azide, diazodinitrophenol, tetrazene, potassium dinitrobenzofuroxane, heavy metal salts of 5-nitrotetrazole, and any combination thereof; and
 - a non-hygroscopic, non-corrosive oxidizer system comprising bismuth oxide, wherein the bismuth oxide comprises at least 15% by weight of the priming mixture.
3. The priming mixture of claim 1, wherein the oxidizer system further comprises a secondary oxidizer selected from potassium nitrate, zinc peroxide, manganese dioxide, molybdenum trioxide, strontium nitrate, strontium peroxide, tin oxide, iron oxide, or combinations thereof.
4. The priming mixture of claim 1, and further comprising a gas producing agent.
5. The priming mixture of claim 4, wherein the gas producing agent is selected from pentaerythritol tetranitrate, trinitrotoluene, or combinations thereof.
6. The priming mixture of claim 1, and further comprising a reducing agent.
7. The priming mixture of claim 6, wherein the reducing agent is selected from aluminum, boron, calcium silicide, magnesium, magnesium-aluminum alloy, silicon, titanium, tungsten, zirconium, nitrocellulose, or combinations thereof.
8. The priming mixture of claim 1, wherein the priming mixture is substantially free of lead.
9. The priming mixture of claim 1, wherein the priming mixture is non-toxic.
10. A small arms ammunition cartridge comprising:
 - a case; and,

the priming mixture of claim 1 disposed in the case.

11. A priming mixture for small arms ammunition comprising:

about 20% to about 70% by weight of a primary explosive selected from the group consisting of: trinitroresorcinol, mercury fulminate, lead azide, lead styphnate, silver azide, diazodinitrophenol, tetrazene, potassium dinitrobenzofuroxane, heavy metal salts of 5-nitrotetrazole, and any combination thereof;

about 10% to about 70% by weight of an oxidizer system comprising bismuth oxide, wherein the bismuth oxide comprises at least 15% by weight of the priming mixture;

about 0% to about 25% by weight of a gas producing agent;

about 0% to about 20% by weight of a sensitizer; and,

about 0% to about 20% by weight of a reducing agent.

12. The priming mixture of claim 11, wherein the priming mixture comprises about 25% to about 50% by weight of the primary explosive.

13. The priming mixture of claim 11, wherein the priming mixture comprises about 25% to about 55% by weight of the oxidizer system.

14. The priming mixture of claim 11, wherein the priming mixture comprises about 5% to about 25% by weight of the gas producing agent.

15. The priming mixture of claim 11, wherein the priming mixture comprises about 5% to about 20% by weight of the sensitizer.

16. The priming mixture of claim 11, wherein the priming mixture comprises about 5% to about 20% by weight of the reducing agent.

18. The priming mixture of claim 11, wherein the oxidizer system further comprises a secondary oxidizer selected from potassium nitrate, zinc peroxide, manganese dioxide,

molybdenum trioxide, strontium nitrate, strontium peroxide, barium nitrate, tin oxide, iron oxide, or combinations thereof.

19. The priming mixture of claim 11, wherein the oxidizer system is non-hygroscopic.
20. The priming mixture of claim 11, wherein the priming mixture is substantially free of lead.
21. The priming mixture of claim 11, wherein the priming mixture is non-toxic.
22. A small arms ammunition round comprising:
 - a priming mixture as disclosed in claim 11;
 - a propellant adapted to be initiated by the priming mixture; and
 - a projectile.
32. A priming mixture for small arms ammunition comprising:
 - about 25% to about 50% by weight of a primary explosive selected from the group consisting of: trinitroresorcinol, mercury fulminate, lead azide, lead styphnate, silver azide, diazodinitrophenol, tetrazene, potassium dinitrobenzofuroxane, heavy metal salts of 5-nitrotetrazole, and any combination thereof; and,
 - about 25% to about 55% by weight of an oxidizer system comprising bismuth oxide, wherein the bismuth oxide comprises at least 15% by weight of the priming mixture.
33. The priming mixture of claim 32, further comprising about 5% to about 25% by weight of a gas producing agent.
34. The priming mixture of claim 33, wherein the gas producing agent is selected from pentaerythritol tetranitrate, trinitrotoluene, or combinations thereof.
35. The priming mixture of claim 32, further comprising about 5% to about 20% by weight of a sensitizer.

36. The priming mixture of claim 35, wherein the oxidizer system is non-corrosive and non-hygroscopic.
37. The priming mixture of claim 32, further comprising about 5% to about 20% by weight of the reducing agent.
38. The priming mixture of claim 37, wherein the reducing agent is selected from aluminum, boron, calcium silicide, magnesium, magnesium-aluminum alloy, silicon, titanium, tungsten, zirconium, or combinations thereof.
40. The priming mixture of claim 32, wherein the oxidizer system further comprises an oxidizer selected from potassium nitrate, zinc peroxide, manganese dioxide, molybdenum trioxide, strontium nitrate, strontium peroxide, barium nitrate, tin oxide, iron oxide, or combinations thereof.
41. The priming mixture of claim 32, wherein the priming mixture is substantially free of lead.
44. The priming mixture of claim 1, further comprising a sensitizer.
45. The priming mixture of claim 44, wherein the sensitizer is tetrazene.

EVIDENCE APPENDIX

An evidence appendix is attached hereto, and contains the Declaration of Donald Alan Pile submitted under 37 CFR § 1.132 and a copy of EP 0 599 792 B1. This Declaration and a copy of EP 0 599 792 B1 were previously filed in the present application with the response of October 2, 2007, and are being relied upon to support the present appeal.

RELATED PROCEEDINGS APPENDIX

Since there are no related appeals and interferences, no decisions have been rendered or attached hereto. Further, since a court nor the Board in any proceeding is identified in the related appeals and interferences section, no decisions have been rendered or attached hereto.

DECLARATION OF DONALD ALLEN PILE

I, DONALD ALLEN PILE, do hereby declare and say as follows:

1.

I am an employee of Remington Arms Co., Inc. ("REMINGTON"), a subsidiary of RA Brands, LLC ("RA BRANDS"). I am over the age of majority and suffer from no disability that would disqualify me from testifying under oath.

2.

This Affidavit is made based on my own personal knowledge and based on knowledge I have gained from my employment at REMINGTON.

3.

I have a Masters of Science degree in Chemistry obtained from University of Arkansas in Little Rock, Arkansas, on 21 December 2000.

4.

I have been employed with REMINGTON from 19 October 1998 until the present. During my tenure with REMINGTON, I have been employed in the following capacities: Explosives Technician, Chemist, and Research Chemist.

5.

I am presently employed by REMINGTON in the capacity of Research Chemist. In this capacity, I am responsible for conducting research, analysis, synthesis, and experimentation on substances, for such purposes as product and process development and application, quantitative analysis, and improvement of analytical methodologies at the Remington Ammunition Plant in Lonoke, Arkansas.

6.

REMINGTON is engaged in the business of research, development, and sale of small arms ammunition. At REMINGTON, I have been directly involved in the research and development of numerous types of small arms ammunition. I have sought intellectual property protection for such ammunition. One result of this effort resulted in U.S. Patent Application

10/764,246, of which I am a named inventor. My familiarity with small arms ammunition is not limited to these efforts.

7.

I have carefully studied U.S. Patent No. 6,478,903 B1 to *John, Jr. et al.* ("*John*"), issued November 12, 2002. I am named as a co-inventor in *John* and I am familiar with each of the primer mixes disclosed therein.

8.

I and my co-inventors in *John* developed the disclosed primer mixes for use in small arms ammunition. We developed several primer mixes with one goal being to obtain a stable, non-toxic primer mix having ballistic properties that were comparable to lead styphnate-based primers.

9.

The primer mixes in *John* are not intended for use as or with delay compositions. In small arms ammunition, it is critical that the round fire nearly simultaneously with trigger pull. Modern primer compositions to my knowledge have detonation velocities of at least 4500 meters per second to ensure the round fires nearly simultaneously with trigger pull. To my knowledge, delay compositions are not used in small arms primer compositions because the resultant delay between trigger pull and firing would result in extremely unsafe firing conditions.

10.

I have carefully studied U.S. Patent No. 5,654,520 to *Boberg et al.* ("*Boberg*"), issued August 5, 1997. I understand the technology in *Boberg* because of my knowledge and experience in working with small arms ammunition.

11.

Boberg discloses delay charges for a detonator. *Boberg* describes the invention as useful in several applications, including start charges, firing charges, transfer charges, with a "main use" as a delay charge (col. 2, lines 31-34). The "suitable burn rate" for the invention is described as "between 10 to 200 mm/s" (col. 2, lines 34-36).

12.

I have reviewed the example charges listed in columns 4-6 of *Boberg* and the burn rates associated therewith. Upon reviewing the burn rates, I notified Mr. C. Keith Montgomery, outside patent counsel for REMINGTON, that there appeared to be errors in the data listed in Examples 2, 4 and 5 of *Boberg*. Mr. Montgomery provided me with a copy of EP 0 599 792 B1, which he informed me is a publication document of the Swedish priority document (SE 9203571) for *Boberg*.

13.

I have reviewed the numerical values listed in Examples 2, 4 and 5 in EP 0 599 792 B1. In my opinion, the numerical values in Examples 2, 4 and 5 of EP 0 599 792 B1, which are measured in millimeters per second, are correct. I believe the values in the corresponding Examples 2, 4 and 5 of *Boberg*, which are measured in meters per second, are typographical errors that should instead be measured in millimeters per second.

14.

I base my conclusion in paragraph 13 in part on *Boberg's* explicit citation of a "suitable burn rate" as falling in the range of "between 10 to 200 mm/s" (col. 2, lines 34-36). Measuring the data in Examples 2, 4 and 5 of *Boberg* in meters per second would place the experimental data far outside of *Boberg's* "suitable" range of 10-200 millimeters per second.

15.

My belief that the data in Examples 2, 4 and 5 of *Boberg* should instead be measured in millimeters per second is reinforced by the discrepancy in data between EP 0 599 792 B1 and *Boberg*.

16.

My belief that the data in Examples 2, 4 and 5 of *Boberg* should instead be measured in millimeters per second is further reinforced by *Boberg's* disclosure of "burn rates," which are typically measured in millimeters per second. "Burning" is deflagration, which occurs relatively slowly, as opposed to detonation, which occurs relatively quickly. Detonation velocities are associated with primer mixes, and are typically measured in meters per second.

17.

If my conclusion in paragraph 13 is correct, the fastest burn rate obtained in the *Boberg* examples is found in Example 2, which discloses a burn rate of 100 millimeters per second. A burn rate of 100 millimeters per second is typical of delay charges and is several orders of magnitude too slow for use in a small arms primer mix such as is disclosed in *John, Jr.*

18.

I have carefully studied U.S. Patent No. 4,853,052 to *Calsson et al.* ("*Calsson*"), issued August 1, 1989. *Calsson* discloses pyrotechnical charges. I understand the technology in *Calsson* because of my knowledge and experience in working with small arms ammunition.

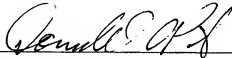
19.

Calsson discloses an ignition charge including bismuth trioxide. I have reviewed the example charges listed *Calsson's* Tables 1 and 2. The fastest example burn rate obtained in the *Calsson* patent is found in Table 2, which discloses a burn rate of 50 millimeters per second. A burn rate of 50 millimeters per second is several orders of magnitude too slow for use in a small arms primer mix. *Calsson* also describes a possible range of burn rates between "3 and 150 mm/sec." (col. 2, lines 3-5), which is also several orders of magnitude too slow for use in a small arms primer mix such as is disclosed in *John, Jr.*

20.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FURTHER DECLARANT SAYETH NAUGHT.



Donald Allen Pile



Date



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) EP 0 599 792 B1

(12)

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(54) Delay charge and element, and detonator containing such a charge

Verzögerungsladung und Element, und Detonator mit solch einer Ladung

Charge à retard et élément, et détonateur contenant une telle charge

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GB-A- 2 049 890 GB-A- 2 098 977
GB-A- 2 241 946 US-A- 2 716 599

• CHEMICAL ABSTRACTS, vol. 103, no. 24, 16
December 1985, Columbus, Ohio, US; abstract
no. 198070J, N. DAVIES ET AL. 'Studies on
gasless delay compositions containing boron
and bismuth trioxide' page 119 ;

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 0 599 792 B1

Description

Technical Field

The present invention relates to a pyrotechnic delay charge for providing delays in the millisecond and second ranges.

Background

Pyrotechnic delay charges are used in many fields, both military and civil, to provide a time delay between an initiating signal, for instance from an electrically activated fuse head or from a fuse, and triggering of a main reaction, such as ignition of a propulsive charge or triggering of a blasting charge. The charges will be described below in greater detail in relation to detonators for civil rock fragmentation.

A leading requirement for pyrotechnic delay charges is that they should burn with a well defined and stable burn rate having an insignificant time scatter. The burn rate should not be significantly influenced by the surrounding conditions or aging. Because of this, a burn having insignificant gas evolution and initial materials, intermediates and end-products with favourable and stable properties is required. The charges should be easily ignitable and provide good ignition transfer to other materials but without being excessively sensitive to jolts, vibration, friction or static electricity. The nominal rate should be adjustable with minor modifications of the charges. The charge compositions should be easy to prepare, dose and compress in safety. The charges should have a high energy content per unit weight and the incorporated components should not be too expensive.

Although conventional pyrotechnic elements can be said, in principle, to consist of a fuel and an oxidant, and therefore many substances should be usable, the above described requirements together significantly limit the choice of suitable initial materials. The component choice has come to be concentrated around a few established components within each field of application. For example, lead compounds are common ingredients in civil detonators.

Even though the amounts of pyrotechnic charge in the majority of initiator types are relatively small, there is a growing requirement that the charges should not contain toxic substances. This is in order to avoid problems during manufacture, to reduce emissions and also to lessen the problem of exposure at the point of end-use. It is also desirable that the preparation of the charges can be done without using solvents. Several components previously used in pyrotechnic elements are now no longer usable, for instance heavy metals.

A number of charges have been proposed with the goal of uniting good pyrotechnic properties with insignificant health consequences. For example, Swedish patent nos. 446 180 and 457 380 describe charges based

on, inter alia, tin oxide as a principal non-toxic oxidant. However, these charges have less satisfactory properties as regards time adjustment and manufacture.

The invention in general

A principal object of the present invention is to provide a delay charge which well fulfills the above general requirements for such charges. A particular object is to provide charges which have stable and reproducible burn times and suitable initial, intermediate and end-product properties. A further object is to provide a charge which does not contain toxic components. An additional object is to provide a charge which is water-insoluble, non-hygroscopic, which may be mixed or prepared in aqueous media, and which is also in other respects easy to handle and safe. Yet another object is to provide a charge which is energy dense and relatively cheap.

These objects are attained with the distinguishing features apparent in the patent claims.

In accordance with the invention, there is provided a delay charge comprising elemental silicon and bismuth oxide. These components are chemically stable, burn without substantial gas evolution and form stable residue products. The resulting delay periods are reproducible, linear and have insignificant scatter. The charges are easy to initiate, even without start charges. The components are entirely non-poisonous. The components are non water-soluble, non-hygroscopic and can be prepared in water. The components are easily handled and have a low price. Also, in other respects, the components exhibit suitable properties in the above-mentioned considerations.

Additional objects of the invention and the benefits attained will be apparent from the detailed description below.

Detailed Description

The charge of the invention can be used for various pyrotechnic objectives, for instance as a start charge, firing charge or transfer charge but the main use is as a delay charge. A suitable burn rate for the charge of the invention is in the range of 10 to 200 mm/s, preferably between 15 and 150 mm/s and especially between 20 and 120 mm/s. For civil detonator applications, the charge is convenient for providing delays of the order of 10 to 3000 ms and especially between 20 and 2000 ms. These charges are hereafter referred to as "fast charges". The invention, however, is also suited to slower charges having burn rates in the range of 1 to 20 mm/s, and especially between 3 and 15 mm/s which are convenient for delays in the range of 0.5 to 10 seconds, especially 1 to 8 seconds. These charges are hereafter referred to as "slow charges". Primers and ignition charges may have burn rates above 150, especially above 200 mm/s.

Without limiting the invention to any theory of function or reaction, and especially not when more than the obligatory components are incorporated, the silicon component will be described below as a fuel component and the bismuth oxide component as an oxidant.

The silicon may be in the amorphous or preferably the crystalline form of the usual grade in the pyrotechnics context. The bismuth oxide is dibismuth trioxide (Bi_2O_3).

The relative amounts of silicon and bismuth oxide can be varied within wide limits. Mixtures which are stoichiometrically deficient in fuel may be used, especially for slow charges. A surplus of the fuel component relative to the oxidant is usually preferred. Under the premise that the silicon reacts to form silicon dioxide and the dibismuth trioxide is reduced to elemental form, a surplus of the silicon in relation to the stoichiometrically necessary amount (3:2) is preferred, preferably a mole ratio in excess of 2:1 or more preferably 3:1. The mole ratio should not exceed 6:1 and it is best not to exceed 5:1.

In absolute terms, it is preferred that the charge contains at least 10 weight percent of silicon, preferably more than 15 weight percent and most preferably more than 20 weight percent. However, the content may be lower and may, for example, go down to around 1 weight percent but is preferably above 2 weight percent. These low amounts of silicon are preferably used for slow charges or in situations where other fuel is incorporated, such as zirconium. The amount of dibismuth trioxide should exceed 30 weight percent, preferably exceeding 40 weight percent and more preferably exceeding 50 weight percent.

Over and above these obligatory components, other reactive and/or inert pyrotechnic additives may be incorporated in order to modify the burn rate or otherwise influence the reaction properties. Similarly, these additives should not give rise to gas releases. Examples of additives include fuels such as zirconium and boron or alternative oxidants such as iron oxide and manganese oxide or more inert components such as silicon oxide and titanium oxide.

The amount of such reactive additives is normally selected so that the total fuel/oxidant relationship falls within the above indicated range. The total amount of additives should not exceed 55 weight percent, preferably not exceeding 45 weight percent and more preferably under 30 weight percent.

Zirconium is a preferred alternative fuel, which provides, inter alia, enhanced ignitability and increased reaction rate. The amount may vary within wide limits, principally depending on the desired speed of the charge and may, for example, be between 1 and 50 weight percent, especially between 3 and 25 weight percent. Slow charges may have a content of between 1 and 20 weight percent, especially between 3 and 15 weight percent. Fast charges may, for example, have a content between 3 and 50 weight percent, especially

between 5 and 25 weight percent. Primers and ignition charges may have a high content, for example exceeding 25 weight percent.

Additives other than pyrotechnic additives may also be incorporated in the charge, for example to improve the properties of the powder in relation to free flow and compactability, or binder additives to improve coherency or to allow granulation, for example clay minerals such as bentonite or carboxymethyl cellulose. The amounts of these sorts of additive are generally kept minor, for example below 4 weight percent, preferably below 2 weight percent and even more preferably under 1 weight percent. The lower of these limits appropriately apply to gas-releasing additives of this type, or are appropriate to gas-releasing additives in general, such as organic additives but also to inorganic additives such as chlorates.

The charges, in the usual manner, are preferably in the form of powder mixtures. The particle size may be used to influence the burn rate. The particle size of the incorporated main components, expressed as a weight average, may be between 0.1 and 100 microns, preferably between 1 and 50 microns. These values may also be appropriate for other optional pyrotechnic powder additives. The powder components or preferably the powder mixture may be granulated in order, for example, to facilitate dosing and compression.

The charges are relatively insensitive to unintended initiation and may be mixed and prepared in the dry state. It is preferred, however, that this is effected in the liquid state. The liquid may be an organic solvent but aqueous media and especially pure water are preferred because the components are water-insensitive. The mixture may be granulated from the liquid phase.

The charges may, as has been indicated, be used for all sorts of pyrotechnic applications, such as ignition charges, start charges etc, but preferably as delay charges, especially in civil detonators. In this connection, the charges are placed in the form of a layer directly in a detonator housing or are accommodated as a column in a surrounding housing element which is inserted into the detonator housing. The charge is placed between a component ignition device, for example a detonating cord, a low energy fuse (for instance Nonel, registered trade mark) or an electrically activated fuse head, and a functional main charge, usually a base charge of secondary explosive. The charge has sufficient initiation ability to be ignited by conventional ignition devices even without a special preceding primer, although these may be used if so desired. In the outward end, the charge may be allowed to act on a primary explosive, optionally via a transfer charge, or to directly ignite a secondary explosive, for example in the primary explosive-free detonator of the type apparent in Swedish patent application nos. 8404208-4 or 8803683-5, which are specifically incorporated herein by reference.

The above charges are generally press compacted.

The exact pressure of the press varies with the length of the charge, the form of the element etc. Appropriate end-densities may be within 10 and 80 percent of the crystal density of the mixture, especially between 20 and 60 percent of the crystal density.

The invention will be further exemplified with the following preferred but non-limiting embodiments.

Examples

A series of test charges was manufactured in accordance with the Examples below. The grain sizes of the incorporated components were determined prior to admixing with the "Fisher Sub Sieve Sizer" method. Admixing of the charges was effected in aqueous phase (c. 40 - 50 weight percent water) with minor amounts of CMC as binder. The order of admixture was: dispersal of the bismuth oxide, addition of the binder in solution form, successive additions of the silicon powder and lastly addition of other, optional components to the mixture. Admixture was effected with the intensive mixer method. After admixture, the charges were oven-dried on trays to a moisture content of around 7 to 10 weight percent, after which granulation was effected on a sieve cloth having a 0.8 mm mesh size, following which the granules were dried to a moisture content below 0.1 weight percent.

The charges were compressed with a pressure of about 1000 kp/cm² in delay elements of aluminium with an inner diameter of 3 mm and a length of 20 mm. The elements were inserted into detonators of the primary explosive containing type as well as the primary explosive-free type and were initiated with a low energy fuse of the Nonel (registered trade mark) type.

The figures indicated below for burn rates are based upon delay periods measured for at least 10 of such detonators for each charge. Elements have also been subjected to storage in humid and warm environments (+40°C and 75% relative humidity). These elements were then inserted into detonators and test-fired as above and showed to have maintained completely satisfactory functions and only insignificantly altered burn rates.

Example 1

A test charge was prepared in accordance with the following specification in which the percentages relate to weight percent and the particle sizes relate to average particle diameter:

28 % Si (silicon), particle size 3 µm
5 % Zr (zirconium), particle size 2 µm
67 % Bi₂O₃ (dibismuth trioxide), particle size 5 µm

The burn rate was measured as 76 mm/second.

Example 2

A test charge was prepared in accordance with the following specification in which the percentages relate to weight percent and the particle sizes relate to average particle diameter:

30 % Si (silicon), particle size 3 µm
20 % Zr (zirconium), particle size 2 µm
50 % Bi₂O₃ (dibismuth trioxide), particle size 5 µm

The burn rate was measured as 100 mm/second.

Example 3

A test charge was prepared in accordance with the following specification in which the percentages relate to weight percent and the particle sizes relate to average particle diameter:

40 % Si (silicon), particle size 3 µm
60 % Bi₂O₃ (dibismuth trioxide), particle size 5 µm

The burn rate was measured as 35 mm/second.

Example 4

A test charge was prepared in accordance with the following specification in which the percentages relate to weight percent and the particle sizes relate to average particle diameter:

30 % Si (silicon), particle size 5 µm
20 % MnO (manganese oxide), particle size 4 µm
50 % Bi₂O₃ (dibismuth trioxide), particle size 5 µm

The burn rate was measured as 20 mm/second.

Example 5

A test charge was prepared in accordance with the following specification in which the percentages relate to weight percent and the particle sizes relate to average particle diameter:

32 % Si (silicon), particle size 3 µm
60 % Bi₂O₃ (dibismuth trioxide), particle size 5 µm
8 % SiO₂ (silicon dioxide), particle size < 1 µm

The burn rate was measured as 11 mm/second.

Example 6

A test charge was prepared in accordance with the following specification in which the percentages relate to weight percent and the particle sizes relate to average particle diameter:

- 3 % Si (silicon), particle size 3 μm
 10 % Zr (zirconium) particle size 2 μm
 60 % Bi_2O_3 (dibismuth trioxide), particle size 5 μm
 27 % TiO_2 (titanium dioxide), particle size < 1 μm

The burn rate was measured as 9 mm/second.

Example 7

A test charge was prepared in accordance with the following specification in which the percentages relate to weight percent and the particle sizes relate to average particle diameter:

- 5 % Si (silicon), particle size 3 μm
 8 % Zr (zirconium) particle size 2 μm
 62 % Bi_2O_3 (dibismuth trioxide), particle size 5 μm
 25 % TiO_2 (titanium dioxide), particle size < 1 μm

The burn rate was measured as 7 mm/second.

Example 8

A test charge was prepared in accordance with the following specification in which the percentages relate to weight percent and the particle sizes relate to average particle diameter:

- 3 % Si (silicon), particle size 3 μm
 97 % Bi_2O_3 (dibismuth trioxide), particle size 5 μm

The burn rate was measured as 5 mm/seconds.

Claims

1. A non-toxic and water-insoluble pyrotechnic delay charge for providing stable and reproducible delays in the millisecond and second ranges, characterized in that it comprises the components dibismuth trioxide as an oxidation agent and silicon (Si) as a fuel, the amount of dibismuth trioxide being more than 30 % by weight.
2. A charge according to claim 1, characterized in that it comprises more than 2 weight percent of silicon.
3. A charge according to claim 2, characterized in that it comprises more than 15 weight percent of silicon.
4. A charge according to any one of the preceding claims, characterized in that it comprises an additive of other reactive and/or inert pyrotechnic components in an amount of no more than 55 % by weight.
5. A charge according to claim 4, characterized in

that the additive comprises zirconium (Zr).

6. A charge according to claim 5, characterized in that the amount of zirconium is between 1 and 47 % by weight of the charge.
7. A charge according to claim 6, characterized in that the amount of zirconium is between 3 and 25 % by weight of the charge.
8. A charge according to any one of the preceding claims, characterized in that it has a stoichiometric excess of fuel.
9. A charge according to any one of the preceding claims, characterized in that it contains a binder in an amount of no more than 4 % by weight.
10. A charge according to claim 9, characterized in that the binder comprises carboxymethyl cellulose.
11. A charge according to any one of the preceding claims, characterized in that the components are in the form of a powder with particle sizes between 0.1 and 100 μm , expressed as weight averages.
12. A charge according to claim 11, characterized in that the components or the charge have been granulated.
13. A charge according to any one of the preceding claims, characterized in that it has a burn rate between 1 and 20 mm/s.
14. A charge according to any one of claims 1 to 12, characterized in that it has a burn rate between 10 and 200 mm/s.
15. A charge according to any one of the preceding claims, characterized in that it has a density between 20 and 60 percent of the crystal density of the mixture.
16. A pyrotechnic delay element for providing a delay in the millisecond and second ranges, characterized in that it comprises an enclosure accommodating a delay charge as defined in any one of claims 1-15.
17. An element according to claim 16, characterized in that the enclosure is constituted by a detonator housing.
18. An element according to claim 16 or 17, characterized in that the enclosure comprises a substantially cylindrical metal casing.
19. An element according to any one of claims 16-18, characterized in that the charge is substantially

cylindrical.

20. An element according to claim 19, **characterized in that the charge diameter is between 1 and 10 mm.**

21. An element according to claim 19 or 20, **characterized in that the charge length is between 1 and 100 mm, especially between 2 and 50 mm.**

22. A detonator comprising a housing, ignition means disposed at one end of the housing, a base charge of a secondary explosive disposed at the other end of the housing and a pyrotechnic delay charge disposed therebetween, **characterized in that the delay charge is as defined in any one of claims 1-15.**

Patentansprüche

1. Nicht-toxische und wasserunlösliche pyrotechnische Verzögerungsladung zum Bereitstellen stabiler und reproduzierbarer Verzögerungen in den Millisekunden- und Sekundenbereichen, **dadurch gekennzeichnet, daß** sie umfaßt die Bestandteile Dibismuttrioxid als ein Oxidationsmittel und Silicium (Si) als Brennstoff, wobei der Gehalt an Dibismuttrioxid mehr als 30 Gew.-% ausmacht.
2. Ladung nach Anspruch 1, **dadurch gekennzeichnet, daß** sie mehr als 2 Gew.-% an Silicium umfaßt.
3. Ladung nach Anspruch 2, **dadurch gekennzeichnet, daß** sie mehr als 15 Gew.-% an Silicium umfaßt.
4. Ladung nach einem der vorangegangenen Ansprüche, **dadurch gekennzeichnet, daß** sie ein Additiv umfaßt an anderen reaktiven und/oder inerten pyrotechnischen Komponenten bzw. Bestandteilen, bei einem Gehalt von nicht mehr als 55 Gew.-%.
5. Ladung nach Anspruch 4, **dadurch gekennzeichnet, daß** das Additiv Zirkon (Zr) umfaßt.
6. Ladung nach Anspruch 5, **dadurch gekennzeichnet, daß** der Gehalt an Zirkon zwischen 1 und 47 Gew.-% der Ladung beträgt.
7. Ladung nach Anspruch 6, **dadurch gekennzeichnet, daß** der Gehalt an Zirkon zwischen 3 und 25 Gew.-%

der Ladung liegt.

8. Ladung nach einem der vorangegangenen Ansprüche, **dadurch gekennzeichnet, daß** sie einen stöchiometrischen Überschuß an Brennstoff enthält.
9. Ladung nach einem der vorangegangenen Ansprüche, **dadurch gekennzeichnet, daß** sie ein Bindemittel enthält bei einem Gehalt bzw. Ausmaß von nicht mehr als 4 Gew.-%.
10. Ladung nach Anspruch 9, **dadurch gekennzeichnet, daß** das Bindemittel Carboxymethylcellulose umfaßt.
11. Ladung nach einem der vorangegangenen Ansprüche, **dadurch gekennzeichnet, daß** die Komponenten bzw. Bestandteile in der Form eines Pulvers vorliegen, mit Partikelgrößen zwischen 0,1 und 100 µm, ausgedrückt als Gewichtsmittelwerte.
12. Ladung nach Anspruch 11, **dadurch gekennzeichnet, daß** die Bestandteile bzw. Komponenten oder die Ladung granuliert wurden.
13. Ladung nach einem der vorangegangenen Ansprüche, **dadurch gekennzeichnet, daß** sie eine Brennrates bzw. -geschwindigkeit zwischen 1 und 20 mm/s aufweist.
14. Ladung nach einem der Ansprüche 1 bis 12, **dadurch gekennzeichnet, daß** sie eine Brennrates zwischen 10 und 200 mm/s aufweist.
15. Ladung nach einem der vorangegangenen Ansprüche, **dadurch gekennzeichnet, daß** sie eine Dichte zwischen 20 und 60 Prozent der Kristalldichte des Gemisches aufweist.
16. Pyrotechnisches Verzögerungselement zum Bereitstellen einer Verzögerung in den Millisekunden- und Sekundenbereichen, **dadurch gekennzeichnet, daß** es umfaßt eine Umhüllung, aufnehmend eine Verzögerungsladung nach einem der Ansprüche 1 bis 15.
17. Element nach Anspruch 16, **dadurch gekennzeichnet, daß**

- die Umhüllung durch ein Detonatorgehäuse gebildet ist.
18. Element nach Anspruch 16 oder 17, dadurch gekennzeichnet, daß die Umhüllung ein im wesentlichen zylindrisches Metallgehäuse umfaßt.
19. Element nach einem der Ansprüche 16 bis 18, dadurch gekennzeichnet, daß die Ladung im wesentlichen zylindrisch ist.
20. Element nach Anspruch 19, dadurch gekennzeichnet, daß der Ladungsdurchmesser zwischen 1 und 10 mm beträgt.
21. Element nach Anspruch 19 oder 20, dadurch gekennzeichnet, daß die Ladungslänge zwischen 1 und 100 mm, insbesondere zwischen 2 und 50 mm, beträgt.
22. Detonator, umfassend ein Gehäuse, eine Zündeinrichtung, angeordnet an einem Ende des Gehäuses, eine Grundladung eines Sekundärsprengstoffes, angeordnet an dem anderen Ende des Gehäuses, und eine pyrotechnische Verzögerungsladung, welche dazwischen angeordnet ist, dadurch gekennzeichnet, daß die Verzögerungsladung eine nach einem der Ansprüche 1 bis 15 ist.
- Revendications**
1. Charge à retard pyrotechnique non toxique et insoluble dans l'eau pour fournir des délais stables et reproductibles de l'intervalle de la milliseconde et de la seconde, caractérisée en ce qu'elle comprend les composants trioxyde de dibismuth comme agent d'oxydation et silicium (Si) comme combustible, la quantité de trioxyde de dibismuth étant supérieure à 30% en poids.
2. Charge selon la revendication 1, caractérisée en ce qu'elle comprend plus de 2% en poids de silicium.
3. Charge selon la revendication 2, caractérisée en ce qu'elle comprend plus de 15% en poids de silicium.
4. Charge selon l'une quelconque des revendications précédentes, caractérisée en ce qu'elle comprend un additif d'autres composants pyrotechniques réactifs et/ou inertes en une quantité ne dépassant pas 55% en poids.
5. Charge selon la revendication 4, caractérisée en ce que l'additif comprend du zirconium (Zr).
6. Charge selon la revendication 5, caractérisée en ce que la quantité de zirconium est comprise entre 1 et 47% en poids de la charge.
7. Charge selon la revendication 6, caractérisée en ce que la quantité de zirconium est comprise entre 3 et 25% en poids de la charge.
8. Charge selon l'une quelconque des revendications précédentes, caractérisée en ce qu'elle comporte un excès stoechiométrique de combustible.
9. Charge selon l'une quelconque des revendications précédentes, caractérisée en ce qu'elle contient un liant en une quantité ne dépassant pas 4% en poids.
10. Charge selon la revendication 9, caractérisée en ce que le liant comprend de la carboxyméthylcellulose.
11. Charge selon l'une quelconque des revendications précédentes, caractérisée en ce que les composants sont sous la forme d'une poudre ayant des tailles particulières comprises entre 0,1 et 100 µm, exprimées en moyennes pondérales.
12. Charge selon la revendication 11, caractérisée en ce que les composants ou la charge ont été granulés.
13. Charge selon l'une quelconque des revendications précédentes, caractérisée en ce qu'elle présente une vitesse de combustion comprise entre 1 et 20 mm/s.
14. Charge selon l'une quelconque des revendications 1 à 12, caractérisée en ce qu'elle présente une vitesse de combustion comprise entre 10 et 200 mm/s.
15. Charge selon l'une quelconque des revendications précédentes, caractérisée en ce qu'elle a une densité comprise entre 20 et 60% de la densité cristalline du mélange.
16. Élément de retard pyrotechnique pour fournir un retard de l'intervalle de la milliseconde et de la seconde, caractérisé en ce qu'il comprend une enceinte abritant une charge à retard telle que définie dans l'une quelconque des revendications 1-15.
17. Élément selon la revendication 16, caractérisé en ce que l'enceinte est constituée par une enveloppe de détonateur.
18. Élément selon la revendication 16 ou 17, caractérisé en ce que l'enceinte comprend un boîtier en

métal sensiblement cylindrique.

19. Elément selon l'une quelconque des revendications 16-18, caractérisé en ce que la charge est sensiblement cylindrique.

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20. Elément selon la revendication 19, caractérisé en ce que le diamètre de la charge est compris entre 1 et 10 mm.

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21. Elément selon la revendication 19 ou 20, caractérisé en ce que la longueur de la charge est comprise entre 1 et 100 mm, en particulier entre 2 et 50 mm.

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22. Détonateur comprenant une enveloppe, un organe d'allumage disposé à une extrémité de l'enveloppe, une charge de base d'un explosif secondaire disposée à l'autre extrémité de l'enveloppe et une charge à retard pyrotechnique disposée entre eux, caractérisé en ce que la charge à retard est telle que définie dans l'une quelconque des revendications 1-15.

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RELATED PROCEEDINGS APPENDIX

Since there are no related appeals and interferences, no decisions have been rendered or attached hereto. Further, since a court nor the Board in any proceeding is identified in the related appeals and interferences section, no decisions have been rendered or attached hereto.